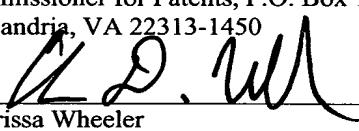


Sole Inventor

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Charissa Wheeler

## APPLICATION FOR UNITED STATES LETTERS PATENT

## S P E C I F I C A T I O N

TO ALL WHOM IT MAY CONCERN:

Be it known that I, **Cheolsoo PARK**, a citizen of the Republic of Korea,  
residing at 891-10 Daechi-dong, Gangnam-gu, Seoul, Korea have invented new and  
useful **METHODS FOR MANUFACURING SEMICONDUCTOR DEVICES**, of  
which the following is a specification.

# METHODS FOR MANUFACTURING SEMICONDUCTOR DEVICES

## FIELD OF THE DISCLOSURE

**[0001]** The present disclosure relates generally to semiconductor devices, and more particularly to methods for manufacturing semiconductor devices.

## BACKGROUND

**[0002]** As semiconductor devices have become more highly integrated, nano-technology approaches have been developed for manufacturing semiconductor devices.

**[0003]** However, a lithography tool or material are insufficient for mass production and, thus, the size of the diameter of the wafer is enlarged. Also, the purchase cost of the tool and the process cost are excessively increased.

**[0004]** U.S. Patent 5,142,350 describes a method of forming a gate after depositing an epitaxially grown silicon layer and a crystalline boron nitride layer on a substrate.

**[0005]** However, such conventional methods cause structural problems and result in high manufacturing cost for the semiconductor device.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0006]** Fig. 1 is a schematic block diagram of an example element isolation mask and an example source/drain mask constructed in accordance with the teachings of the present disclosure.

**[0007]** Figs. 2A to 2E are cross-sectional views illustrating an example procedure for forming a transistor in accordance with the teachings of the present disclosure.

**[0008]** Fig. 3 is a plan view of the silicon substrate after planarizing the second nitride.

**[0009]** Fig. 4 is a schematic block diagram of an example gate electrode mask constructed in accordance with the teachings of the present disclosure.

**[0010]** In the accompanying drawings, like reference numerals appearing in the drawings represent like parts.

## DETAILED DESCRIPTION

**[0011]** Fig. 1 is a schematic block diagram of an example element isolation mask 100 and an example source/drain mask 200.

**[0012]** Figs. 2A to 2E illustrate an example procedure for forming a transistor.

**[0013]** Referring to Fig. 2A, an element isolation oxide layer 2 is thermally grown on a silicon substrate 1 to an isolation depth. A first nitride layer 3 is then deposited on the element isolation oxide layer 2. A first photoresist (not shown) is then patterned using the element isolation mask

100. The first nitride layer 3 and the element isolation oxide layer 2 are sequentially etched by an anisotropic dry etching process to thereby expose the silicon substrate 1 in a portion where an active region is formed. Thereafter, the first photoresist is removed and a cleaning process for the silicon substrate 1 is performed. Next, an epitaxial active region 4 is epitaxially grown on the silicon substrate 1. A first oxide layer 5 is then deposited on the epitaxial active region 4 to a thickness of a gate electrode to be formed later. A second photoresist 6 is patterned using the source/drain mask 200. The first oxide layer 5 is then etched by the anisotropic dry etching process. At this time, the first oxide layer 5 is not entirely removed and remains with a predetermined thickness. In Fig. 2A, L is a width between a source and a drain so that L is a channel length of the gate electrode to be formed later.

**[0014]** Referring now to Fig. 2B, the photoresist 6 is removed. Next, the remaining first oxide layer 5 located on portions of the source/drain 7a and 7b to be formed later is removed using a diluted hydrofluorine (HF) solution so that the source/drain 7a and 7b can be formed by a doped epitaxial growth and the channel length of a gate to be formed later can also be controlled. Thereafter, the source 7a and the drain 7b are doped-epitaxially grown. A second nitride layer 8 whose thickness is not less than that of the first oxide layer 5 is deposited.

**[0015]** Referring to Fig. 2C, the second nitride layer 8 is planarized using a chemical mechanical polishing (CMP) method.

**[0016]** Fig. 3 depicts a plan view of the example silicon substrate after planarizing the second nitride layer 8. As can be seen from Fig. 3, the source/drain active regions 7a and 7b are separated from each other by means of the planarized second nitride layer 8.

**[0017]** Fig. 4 is a schematic block diagram of an example gate electrode mask 300.

**[0018]** Referring back to Fig 2D, a third photoresist 9 is pattered by using the gate electrode mask 300. The exposed first oxide layer 5 is etched away using a wet etching etchant to thereby expose the active region 4.

**[0019]** Referring to Fig. 2E, the third photoresist 9 is removed. Then a second nitride layer 10 is deposited on the overall surface and etched back. By doing this, the second nitride layer 10 for use in controlling the length of the gate remains at a predetermined thickness, e.g., 1. Next, a local channel 11 is ion-implanted. Then a gate insulation layer 12 and a gate electrode 13 are sequentially deposited on the active region 4. Thereafter, the gate electrode 13 is planarized. A second oxide layer 14 is then thickly deposited. A gate electrode plug 15a, a source electrode plug 15b and a drain electrode plug 15c are then formed.

**[0020]** From the foregoing, persons of ordinary skill in the art will appreciate that a gate having a fine pattern can be formed by using the second nitride layer 10 to control the channel length of the gate. Thus, new methods capable of enhancing an operating characteristic of a transistor and reducing a cost of a lithography tool are provided.

**[0021]** From the foregoing, persons of ordinary skill in the art will further appreciate that the above disclosed methods and apparatus provide a transistor capable of enhancing an operating characteristic thereof by depositing a nitride layer for controlling a length of a gate channel in a formation of a gate thereby reducing the cost of a lithography tool.

An example method for fabricating a semiconductor device, comprises: (a) depositing an isolation oxide layer and a first nitride layer on a semiconductor substrate; (b) forming a trench in an active region by etching the first nitride layer and a portion of the semiconductor substrate; (c) performing an epitaxial growth on the active region and depositing a first oxide layer thereon; (d) etching portions of the first oxide layer where a source and a drain are to be formed by using a source/drain mask, wherein the etched first oxide layer has a predetermined thickness; (e) etching the first oxide layer deposited on the portions where the source and the drain are to be formed, performing an epitaxial growth on the portions where the source and the drain are to be formed to thereby form the source and the drain, and depositing a second nitride layer thereon; (f) etching the first oxide layer in a portion where a gate is to be formed using a gate mask; (g) depositing and planarizing a third nitride layer on the source, the drain, and the exposed active region to thereby form a nitride layer for use in controlling a length of the gate; (h) sequentially depositing a gate isolation layer and a gate electrode on the active region; and (i) depositing a dielectric layer on the resultant structure, and forming plugs on the source, drain, and gate respectively.

**[0022]** Although certain example methods and apparatus have been described herein, the scope of coverage of this patent is not limited thereto. On the contrary, this patent covers all methods, apparatus and articles of manufacture fairly falling within the scope of the appended claims either literally or under the doctrine of equivalents.